Evaluating Geographic Patterns of Morphological Diversity in Ferns and Lycophytes Using Deep Neural Networks

Alexander E White[‡], Michael G Trizna[‡], Paul B Frandsen[§], Laurence J Dorr[|], Rebecca B Dikow[‡], Eric Schuettpelz[|]

‡ Data Science Lab, Smithsonian Institution, Washington, DC, United States of America
§ Brigham Young University, Provo, UT, United States of America
| National Museum of Natural History, Smithsonian Institution, Washington DC, United States of America

Abstract

With digitized herbarium specimens and associated metadata accumulating rapidly in open access repositories, we are now able to exploit data-hungry computer vision techniques in order to evaluate fundamental questions in plant evolution. High among the list of unknowns is the role that ecological factors, such as morphological similarity, play in mediating biogeographic patterns of taxonomic and phylogenetic diversity. Here, we integrate deep convolutional neural networks (CNNs) into a biogeographic study of morphological, taxonomic, and phylogenetic diversity in ferns and lycophytes. We show how CNNs and digitized specimens can be used to extract quantitative estimates of morphospace occupation, and we use these techniques to evaluate diversity-disparity relationships within ferns across latitudes. We also discuss how CNNs can be used to overcome logistical obstacles arising from modern workflows involving millions of images.

Keywords

biogeography, deep learning, convolutional neural networks, morphospace, latitudinal diversity gradient

Presenting author

Rebecca B Dikow

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